

## Theory of plane copper and oxygen nuclear spin-lattice relaxation rates in lightly doped $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$

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### Abstract

Using a Mori-Zwanzig projection operator procedure the relaxation function theory of doped two-dimensional  $S=1/2$  Heisenberg antiferromagnetic (AF) system in the paramagnetic state is presented taking into account the hole subsystem as well as both the electron and AF correlations. At low temperatures the main contribution to the nuclear spin-lattice relaxation rate,  $63(1/T^1)$ , of plane  $^{63}\text{Cu}$ , arises from the AF fluctuations, and  $17(1/T^1)$ , of plane  $^{17}\text{O}$ , has the contributions from the wave vectors in the vicinity of  $(\pi, \pi)$  and small  $q \sim 0$ . The effects of thermal spin-wave damping  $\Gamma q$  on  $17(1/T^1)$  in lightly doped regime are investigated, suggesting either a polynomial of up to third order (not simply  $(T/J)^3$ ) or exponential temperature dependence of  $\Gamma q$  at low temperatures. It is shown that the theory is able to explain the main features of experimental data on temperature and doping dependence of  $17, 63(1/T^1)$  in the paramagnetic state of  $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$  compounds. © Springer Science+Business Media, LLC 2006.

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### Keywords

$\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ , NMR, Relaxation function, Spin-wave damping